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(54) Co-Cr-Pt BASED TARGET MATERIAL AND MAGNETIC RECORDING MEDIUM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a Co based target material less in the fluctuation of magnetic characteristics such as coercive force and a squareness ratio of a magnetic film and excellent in film characteristics.

SOLUTION: The erosion part of the sputtering surface of the target material has <1.50 μm arithmetic average roughness Ra and the target material preferably has the composition consisting of 5≤Cr≤30 at.%, 5≤Pt≤30 at.% and the rest essentially consisting of Co. The target material may contain 0<B≤25 at.% and 0<(Ti+Zr+Hf+V+Nb+Ta+Mo+W+Mn+Re+Ru+Os+Rh+Ir+Ni+Pd+Cu+Ag+Au+C)≤40 at.%. A matrix preferably has ≤40 μm average crystal grain size, ≥3 N purity, ≤50 ppm Fe content and ≤20 ppm oxygen content.

[Claim 1]A Co-Cr-Pt system target material, wherein arithmetic-mean-roughness Ra in an erosion part of a sputtering surface of a target material is less than 1.50 micrometers.

[Claim 2]The Co-Cr-Pt system target material according to claim 1 containing one sort or two sorts or more of elements chosen from B, Ti, Zr, Hf, V, Nb, Ta, Mo, W, Mn, Re, Ru, Os, Rh, Ir, nickel, Pd, Cu, Ag, Au, and C.

[Claim 3]The Co-Cr-Pt system target material according to claim 1 or 2 characterized by being 5 <=Pt<=30at% 5 <=Cr<=30at%.

[Claim 4]The Co-Cr-Pt system target material according to any one of claims 1 to 3 being 0<B<=25at%.

[Claim 5]The Co-Cr-Pt system target material according to any one of claims 1 to 4 being 0<(Ti+Zr+Hf+V+Nb+Ta+Mo+W+Mn+Re+Ru+Os+Rh+Ir+nickel+Pd+Cu+Ag+Au+C) <=40at%.

[Claim 6]The Co-Cr-Pt system target material according to any one of claims 1 to 5, wherein an average crystal grain diameter of a matrix is 40 micrometers or less.

[Claim 7]The Co-Cr-Pt system target material according to any one of claims 1 to 6, wherein purity is more than 3N.

[Claim 8]The Co-Cr-Pt system target material according to any one of claims 1 to 7, wherein a Fe content is 50 ppm or less.

[Claim 9]The Co-Cr-Pt system target material according to any one of claims 1 to 8, wherein an oxygen content is 20 ppm or less.

[Claim 10]A magnetic recording medium currently forming at least one or more layers of Co-Cr-Pt system thin films which used the Co-Cr-Pt system target material according to any one of claims 1 to 9, and formed membranes on a nonmagnetic substrate.

[Detailed Description of the Invention]

[0001]
[Field of the Invention]This invention relates to the magnetic recording medium produced using the Co-Cr-Pt system target material and this target material which are used in order to form the magnetic film of the magnetic recording medium used for a magnetic disk drive etc.

[0002]

[Description of the Prior Art]Conventionally, Co system magnetic film is developed so that high-density magnetic recording may become possible, and addition of Cr and Pt has been performed to Co system magnetic film. By these days, it is reported to J.Appl.Phys.84, 6202(1998)., etc. by by adding B to a Co-Cr-Pt system magnetic film that magnetic properties are improved remarkably.

[0003]As a method of producing this Co-Cr-Pt system magnetic film, sputtering process etc. can be used so that it may be indicated in the literature etc. which were mentioned above. In sputtering process, the target material used as the supply source of film composition is needed. After the target material used in order to form an above-mentioned Co-Cr-Pt system magnetic film usually hot-rolls to the ingot dissolved and cast, it is machined and the target material is produced.
Surface finish is performed by cutting of an engine lathe etc.

[0004]

[Problem(s) to be Solved by the Invention]Since expensive Pt is conventionally added as a reason for having performed surface finish of the Co-Cr-Pt system target material by cutting, it is because it is easier to collect as cut powder from the viewpoint of recycling. When polish finishing performed surface finish, the abrasive grain sank into the target material surface, and it was thought that it became a cause of membrane-characteristics degradation. As a result, arithmetic-mean-roughness Ra of the Co-Cr-Pt system target material produced by the conventional cutting was not less than 1.50 micrometers. When the magnetic film was made to form using the target material produced by such a method, the problem which dispersion produces in the magnetic properties of the coercive force and the square-shaped ratio of a magnetic film which were produced occurred. The purpose of this invention has little dispersion in the magnetic properties mentioned above, and is providing Co system target material excellent in membrane characteristics.

[0005]
[Means for Solving the Problem]A result which this invention person investigated about influence of magnetic properties on a sputter film of arithmetic-mean-roughness Ra in an erosion part of a sputtering surface of a Co-Cr-Pt system target material, It turned out that arithmetic-mean-roughness Ra in an erosion part of a sputtering surface of a target material has big influence on film composition, especially the amount of Pt(s) in a film. It became clear that film composition especially the amount of Pt(s) in a film, and its variation had big influence on the magnetic properties of coercive force and a square-shaped ratio in a magnetic film of a magnetic recording medium.

[0006]Alloy target material which consists of combination of an element with large specific gravity difference like a Co-Cr-Pt system target material, Directivity may arise on sputtered particles at the time of weld slag, especially a discharge square of an element with large specific gravity, and that a difference of film composition and a target presentation becomes large, and when variation in film composition becomes large, dispersion in the magnetic properties of coercive force and a square-shaped ratio in a magnetic film of a magnetic recording medium may arise. However, it was not thought that surface roughness was influenced greatly.

[0007]Surface roughness in an erosion part of a sputtering surface of a target material, Although there is nothing with regards to essence in a problem of a discharge angle of sputtered particles mentioned above, when surface roughness becomes coarse, When an incidence angle with a target surface of acceleration ion, such as that an inclined plane of a target surface increasing and surface area change and Ar ion, etc. change, it is thought that the directivity of a discharge angle of sputtered particles becomes remarkable.

[0008]this invention person considered relation between the sputter film characteristic of a Co-Cr-Pt system target material, and surface roughness in an erosion part of a sputtering surface, is managing arithmetic-mean-roughness Ra which shows surface roughness, found out that dispersion in magnetic properties could be reduced, and reached this invention.

[0009]That is, this invention is a Co-Cr-Pt system target material, wherein arithmetic-mean-roughness Ra in an erosion part of a sputtering surface of a target material is less than 1.50 micrometers.

[0010]As a desirable presentation of Co system target material of this invention, 5 <=Pt<=30at%, it is preferred on a remainder real target that it is Co, and it is also still more possible for 0<B<=25at% to be included 5 <=Cr<=30at%. Ti, Zr, Hf, V, Nb, Ta, Mo, W, Mn, Re, Ru, Os, Rh, Ir, nickel, Pd, Cu, Ag, one sort or two sorts or more of elements chosen from Au and C -- 0<(Ti+Zr+Hf+V+Nb+Ta+Mo+W+Mn+Re+Ru+Os+Rh+Ir+nickel+Pd+Cu+Ag+Au+C) <=40at% -- containing is also possible.

[0011]As for a Co-Cr-Pt system target material of this invention, it is preferred that content of more than 3N and Fe is that an average crystal grain diameter of a matrix is 40 micrometers or less, purity is 50 ppm or less, and an oxygen content is 20 ppm or less. By forming a Co-Cr-Pt system magnetic film using a Co-Cr-Pt system target material of this invention, it becomes possible to be stabilized and to perform manufacture of a magnetic recording medium.

[0012]
[Embodiment of the Invention]There is the greatest feature of this invention in arithmetic-mean-roughness Ra in the erosion part of the sputtering surface of a target material having been less than 1.50 micrometers in the Co-Cr-Pt system target material.

[0013]The Co-Cr-Pt system target material of this invention, arithmetic-mean-roughness Ra in the erosion part of the sputtering surface of a target material shall be less than 1.50 micrometers -- the amount of Pt(s) in a film -- a target presentation and equivalent -- or, Presentation variation is reduced at the same time it carries out more than equivalent, the coercive force at the time of forming the magnetic film of a magnetic recording medium and dispersion of the magnetic properties of a square-shaped ratio are controlled, and stable manufacture of a magnetic recording medium is brought about. Arithmetic-mean-roughness Ra is less than 1.00 micrometers more preferably, and is less than 0.50 micrometer still more preferably. However, when performing processing which makes the erosion outside circumference of a sputtering surface, etc. roughen surface roughness intentionally in order to prevent exfoliation of an affix, the surface roughness of the roughening field is not contained in regulation of arithmetic-mean-roughness Ra of this invention.

[0014]The method of smoothing the surface of the target material cut, for example by dry etching as the concrete technique of setting arithmetic-mean-roughness Ra to less than 1.50 micrometers, and carrying out minuteness making of arithmetic-mean-roughness Ra by this invention, is effective. However, the surface finishing method in this invention is not limited to the method mentioned above, and although productivity falls, it is possible also in selecting reducing the feed rate of the edge for cutting at the time of cutting, i.e., a byte, and the kind of edge for cutting. The method of removing the abrasive grain which

sank into the target surface by dry etching etc. is also applicable after polish finishing.

[0015]The desirable composition range of the Co-Cr-Pt system target material of this invention is Co 5 <=Pt<=30at% 5 <=Cr<=30at% at a remainder real target. By carrying out a segregation to a grain boundary in a film, and making a grain boundary nonmagnetic, Cr has an effect divided magnetically for ferromagnetic Co grain, and in addition below 5at%. Magnetic division is not enough, and the addition exceeding 30at% is [5 <=Cr<=30at% of] desirable in order to reduce magnetization of the film itself too much.

[0016]By dissolving to Co, Pt improves magnetic anisotropy and is effective in raising membranous coercive force. The addition which a prominent effect is seen and exceeds 30at% by carrying out addition beyond 5at% to coercive force increase is [5 <=Pt<=30at% of] desirable in order to reduce remarkably magnetic properties, such as magnetic anisotropy which is the characteristic which Co originally has.

[0017]As for B, it is effective to add as an alloying element which improves magnetic properties. The segregation of the B is carried out to a grain boundary in a film, it has an effect to which the segregation of the Pt element is carried out into a grain, and there is an effect to which the segregation also of the nonmagnetic elements, such as Cr, is further carried out to a grain boundary. However, if addition which is an element which promotes amorphous-ization and exceeds 25at% is performed, in order that B may spoil membranous crystallinity and may degrade membranous magnetic properties, it is desirable. [0<B<=25at% of]

[0018]Ti, Zr, Hf, V, Nb, Ta, Mo, W, Mn, Re, Ru, Os, Rh, Ir, nickel, Pd, Cu, Ag, Au, and C addition can be added as an alloying element which improves magnetic properties. Although an effect is accepted by a little addition, these elements, If 40at% is exceeded in a total amount, in order to spoil membranous magnetic properties and crystallinity remarkably,
0<(Ti+Zr+Hf+V+Nb+Ta+Mo+W+Mn+Re+Ru+Os+Rh+Ir+nickel+Pd+Cu+Ag+Au+C) <=40at% is preferred.

[0019]In the Co-Cr-Pt system target material of this invention, the coercive force of the magnetic film of a Co-Cr-Pt system sputter film and dispersion of the magnetic properties of a square-shaped ratio can be further reduced by the average crystal grain diameter of a matrix being 40 micrometers or less. It is 20 micrometers or less still more preferably. It is effective to perform hot-rolling and plastic working between heat like hot forging, for example as a concrete method of adjusting the mean particle diameter of a matrix to 40 micrometers or less, and to make a matrix recrystallize.

[0020]The target material with little dispersion in the average crystal grain diameter of a matrix becomes producible by controlling plastic-working conditions between heat, such as working ratio at the time of plastic working between heat, for example. Since dispersion will specifically become large with the anisotropy at the time of plastic working between heat if working ratio is too high, and no recrystallization sets and there

is when too low, there is no effect of plastic working between heat. Since the anisotropy of the organization by rolling seldom appears by, for example, performing crossing rolling when hot-rolling as plastic working between heat, it is desirable. It is also possible to heat-treat before and after plastic working between heat, and to perform structure control.

[0021]As for the Co-Cr-Pt system target material of this invention, it is preferred that purity is more than 3N. Since especially Fe and oxygen are easy to degrade membrane characteristics that it is easy to mix in a target material as an impurity, it is preferred to prevent contamination as much as possible. Since membrane characteristics fell when purity falls, but membrane characteristics deteriorated rapidly by becoming the impurity quantity not more than 3N, purity was made more than 3N, but more than 4N is more than 5N still more preferably preferably. Here, purity is the rate which deducted the total amount of elements other than the main ingredients from 100 by mass %, 3N means 99.9%, 4N means 99.99%, and 5N means 99.999%.

[0022]When 50 ppm was exceeded, since membrane characteristics deteriorated, Fe set to 50 ppm or less, but 30 ppm or less are 10 ppm or less still more preferably preferably. When 20 ppm was exceeded, since membrane characteristics deteriorated, oxygen was 20 ppm or less, but it is 10 ppm or less preferably. ppm means mass ppm here.

[0023]
[Example](Example 1) The target material with the presentation of Co-20Cr-10Pt-5B (at%) shown in Table 1 of phi180-mmx5mmt was produced. The samples 1-10 performed vacuum melting and rolling between casting post heating, and produced the target material. The samples 1-5 performed the dissolution and casting using Co raw material with few Fe amounts, and the reduction of sectional area at the time of hot-rolling performed them at 50%. The samples 6-10 performed the dissolution and casting using a little high Co raw material of a Fe amount, and the reduction of sectional area at the time of hot-rolling performed them at 25%. The samples 11-15 produced the target material by powder sintering. Surface roughness was changed by controlling the feed rate of the byte of cutting with the engine lathe at the time of surface-finish processing.

[0024]All over Table 1, an optical microscope performs arithmetic-mean-roughness Ra in the erosion part of the sputtering surface of the target material measured based on JIS-B0601, and a microstructure from a sputtering surface, and the analytical value of the matrix average crystal grain diameter by an intercept method, Fe, and oxygen is shown. The analysis result by GD-MS of the sample 1 is shown in Table 2 as an example. The surface roughness curve of the samples 2 and 3 of this invention and the sample 5 of a comparative example is shown in drawing 1, drawing 2, and drawing 3.

[0025]The magnetic film was formed using the Al substrate which performed NiP plating with the target material of Co-20Cr-10Pt-5B (at%) produced on the substrate on the various conditions shown in Cr ground film and Table 1 on condition of the substrate temperature of 150 **, Ar pressure 0.66Pa, and DC power 500W. In order to investigate characteristic dispersion of a magnetic film, the measuring result of the coercive force Hc

which produced the film formation substrate with one time interval from 1 hour to 4 hours, and measured the total membrane formation time by VSM (vibrating sample magnetometer) is shown in Table 3.

[0026]Table 3 shows making small arithmetic-mean-roughness Ra in the erosion part of the sputtering surface of a Co-Cr-Pt system target material, and that improvement and stabilization of the membrane characteristics at the time of weld slag membrane formation are made by specifically being referred to as less than 1.50 micrometers specified by this invention.

[0027]

[Table 1]

試料	Ra (μm)	平均結晶粒径 (μm)	Fe (ppm)	酸素 (ppm)	備考
1	0.27	22	42	8	本発明
2	0.48	22	42	8	本発明
3	0.68	22	42	8	本発明
4	1.03	22	42	8	本発明
5	1.52	22	42	8	比較例
6	0.25	51	76	10	本発明
7	0.42	51	76	10	本発明
8	0.71	51	76	10	本発明
9	1.10	51	76	10	本発明
10	1.55	51	76	10	比較例
11	0.29	5	45	64	本発明
12	0.38	5	45	64	本発明
13	0.65	5	45	64	本発明
14	1.06	5	45	64	本発明
15	1.53	5	45	64	比較例

[0028]

[Table 2]

元素	分析値	元素	分析値	元素	分析値
Li	<928ppt	As	<2.6ppb	Nd	<4.4ppb
Be	<764ppt	Se	<22ppb	Sm	<2.7ppb
C	10.8ppm	Br	<1.4ppb	Eu	<969ppt
N	1.96ppb	Rb	<711ppb	Gd	<2.4ppb
O	<6.8ppb	Sr	1.59ppm	Tb	<360ppb
Na	<1.0ppb	Y	120ppb	Dy	<2.0ppb
Mg	<1.0ppb	Zr	<847ppb	Ho	<408ppt
Al	23.4ppm	Nb	52.6ppm	Er	<1.6ppb
Si	95.4ppm	Mo	<5.9ppb	Tm	<436ppt
P	2.59ppm	Ru	1.73ppm	Yb	<3.4ppb
S	9.28ppm	Rh	798ppb	Lu	<428ppb
Cl	996ppb	Pd	900ppb	Hf	<1.2ppb
K	38.2ppb	Ag	<4.5ppb	Ta	4.99ppm
Ca	104ppb	Cd	22.9ppb	W	698ppb
Sc	16.8ppb	In	468ppb	Re	31.9ppb
Ti	8.69ppm	Sn	12.4ppm	Os	<3.1ppb
V	163ppb	Sb	<4.7ppb	Ir	3.16ppm
Mn	2.52ppm	Te	<24ppb	Au	243ppb
Fe	45ppm	I	<513ppt	Hg	5.56ppm
Ni	122ppm	Cs	<513ppt	Tl	46.9ppm
Cu	10.1ppm	Ba	<13ppb	Pb	<5.4ppb
Zn	1.33ppm	La	<574ppt	Bi	24.2ppm
Ga	46.6ppb	Ce	<431ppt	Th	<43ppb
Ge	<37ppb	Pr	<413ppt	U	<115ppb

[0029]

[Table 3]

試料	保磁力（Oe）［（kA/m）］				備考
	1時間	2時間	3時間	4時間	
1	3163 [252]	3161 [252]	3167 [252]	3169 [252]	本発明
2	3155 [251]	3158 [251]	3150 [251]	3164 [252]	本発明
3	3142 [250]	3140 [250]	3151 [251]	3147 [251]	本発明
4	3136 [250]	3130 [250]	3145 [250]	3140 [250]	本発明
5	3066 [244]	3091 [246]	3077 [245]	3107 [247]	比較例
6	3144 [250]	3150 [251]	3150 [251]	3156 [251]	本発明
7	3141 [250]	3142 [250]	3147 [251]	3150 [251]	本発明
8	3123 [249]	3127 [249]	3132 [249]	3138 [250]	本発明
9	3115 [248]	3121 [248]	3127 [249]	3132 [249]	本発明
10	3091 [246]	3061 [244]	3077 [245]	3097 [247]	比較例
11	3150 [251]	3145 [250]	3151 [251]	3153 [251]	本発明
12	3151 [251]	3142 [250]	3152 [251]	3145 [250]	本発明
13	3120 [248]	3125 [249]	3131 [249]	3128 [249]	本発明
14	3111 [248]	3116 [248]	3133 [249]	3131 [249]	本発明
15	3074 [245]	3090 [246]	3081 [245]	3037 [240]	比較例

[0030]

[Example](Example 2) The target with the presentation shown in Table 4 of phi180-mmx5mmt was produced. The target produced after vacuum melting and casting by performing hot-rolling of 50% of reduction of sectional area. Surface roughness was changed by controlling the feed rate of the byte of cutting with the engine lathe at the time of surface-finish processing.

[0031]An optical microscope performs the arithmetic mean roughness in the erosion part of the sputtering surface of the target material measured based on JIS-B0601 of the target material produced to Table 5, and a microstructure from a sputtering surface, and the analytical value of the matrix average crystal grain diameter by an intercept method, Fe,

and oxygen is shown.

[0032]The magnetic film was formed on the substrate using the Al substrate which performed NiP plating with the substrate temperature of 150 **, Ar pressure 0.66Pa, and the Co-Cr-Pt system target material shown in Cr ground film and Table 4 on condition of DC power 500W. In order to investigate characteristic dispersion of a magnetic film, the measuring result of the coercive force Hc which produced the film formation substrate with one time interval from 1 hour to 4 hours, and measured the total membrane formation time by VSM (vibrating sample magnetometer) is shown in Table 6.

[0033]Table 6 shows making small arithmetic-mean-roughness Ra in the erosion part of the sputtering surface of a Co-Cr-Pt system target material, and that improvement and stabilization of the membrane characteristics at the time of weld slag membrane formation are made by specifically being referred to as less than 1.50 micrometers specified by this invention.

[0034]
[Table 4]

試料	組成（at%）
16	Co−20Cr−10Pt
17	Co−20Cr−10Pt
18	Co−20Cr−10Pt−2Ta
19	Co−20Cr−10Pt−2Ta
20	Co−20Cr−10Pt−2Ta−5B
21	Co−20Cr−10Pt−2Ta−5B
22	Co−20Cr−10Pt−5Ni−5B
23	Co−20Cr−10Pt−5Ni−5B
24	Co−20Cr−10Pt−2Cu−5B
25	Co−20Cr−10Pt−2Cu−5B

[0035]

[Table 5]

試料	Ra (μm)	平均結晶粒径 (μm)	Fe (ppm)	酸素 (ppm)	備考
16	0.65	32	38	17	本発明
17	1.51	32	38	17	比較例
18	0.67	26	37	15	本発明
19	1.51	26	37	15	比較例
20	0.65	14	42	11	本発明
21	1.52	14	42	11	比較例
22	0.69	23	48	18	本発明
23	1.53	23	48	18	比較例
24	0.66	19	46	13	本発明
25	1.54	19	46	13	比較例

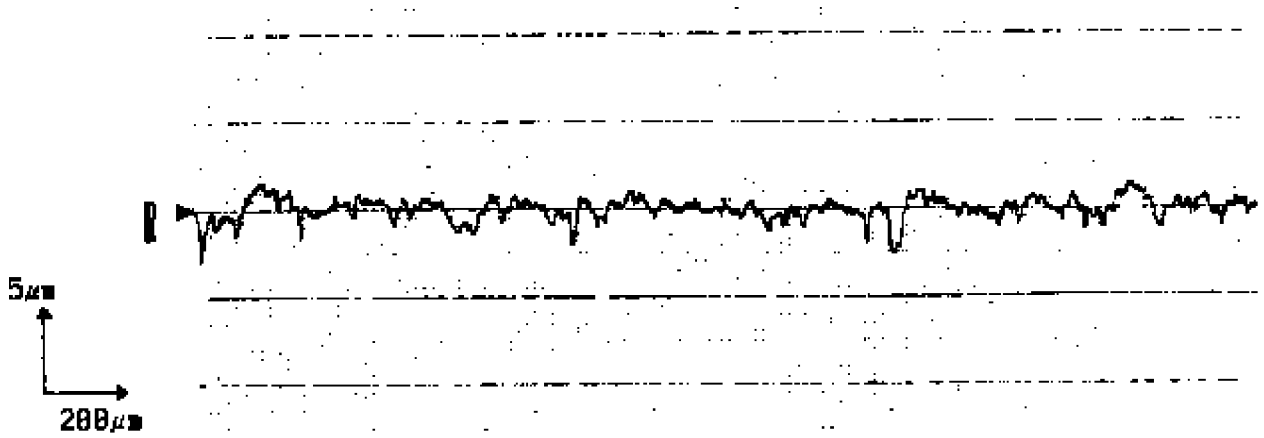
[0036]

[Table 6]

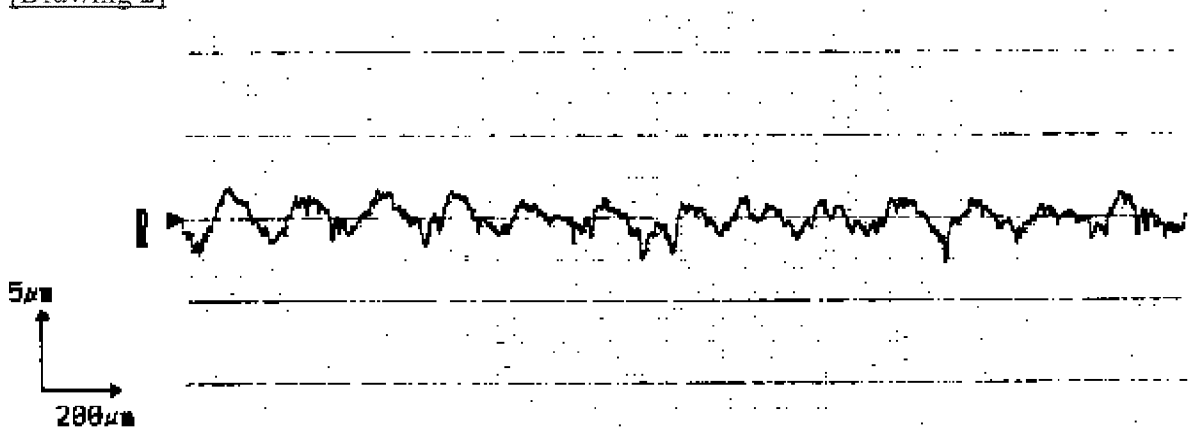
試料	保磁力（Oe）［（kA/m）］				備考
	1時間	2時間	3時間	4時間	
16	2939 [234]	2943 [234]	2950 [235]	2948 [235]	本発明
17	2853 [227]	2874 [229]	2908 [231]	2833 [226]	比較例
18	3056 [243]	3055 [243]	3063 [244]	3067 [244]	本発明
19	2972 [237]	2978 [237]	2943 [234]	2954 [235]	比較例
20	3168 [252]	3165 [252]	3174 [253]	3176 [253]	本発明
21	3057 [243]	3060 [244]	3082 [245]	3043 [242]	比較例
22	3143 [250]	3139 [250]	3145 [250]	3150 [251]	本発明
23	3085 [246]	3093 [246]	3073 [245]	3102 [247]	比較例
24	3166 [252]	3173 [253]	3171 [252]	3172 [252]	本発明
25	3051 [243]	3053 [243]	3076 [245]	3033 [241]	比較例

[0037]

[Effect of the Invention]With the Co-Cr-Pt system target material of this invention, it became the art which it becomes possible to have excelled in magnetic properties, and is indispensable to the Co-Cr-Pt system magnetic film used into the magnetic recording media for magnetic disk drives etc. at manufacture of a magnetic recording medium.



[Drawing 2]



[Drawing 3]